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TAXONOMIC CHARACTERS OF THE GENUS *OCHODAEUS* SERVILLE WITH
DESCRIPTIONS OF TWO NEW SPECIES IN THE *O. PECTORALIS* LECONTE
SPECIES COMPLEX (COLEOPTERA: SCARABAEIDAE)

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ABSTRACT: The mandibles, stridulatory peg, and male genitalia of the adults of eight species of *Ochodaecus* found in the United States have useful characters for the delineation of species and are described and figured. The most useful taxonomic feature of the male genitalia is the aedeagal sac. The taxonomic characters of *Ochodaecus* are reviewed and a key to the species of the *O. pectoralis* species complex is presented.

The *Ochodaecus pectoralis* species complex is erected to contain the nominate species *O. pectoralis* LeConte and two new species which are described. The other five species considered are *O. biarmatus* LeConte, *O. inarmatus* Schaeffer, *O. kansanus* Fall, *O. praesidii* Bates, and *O. simplex* LeConte. A lectotype is designated for *O. inarmatus* Schaeffer.

The genus *Ochodaecus* Serville is one of six genera included in the subfamily Ochodaecinae. Approximately half of the sixty species of *Ochodaecus* occur in the New World (Arrow, 1912) and of these, twenty are from the United States, ten from Mexico and Central America, and five from South America. Species of *Ochodaecus* are distributed throughout North America with the greatest number occurring in the arid southwestern United States and northern portions of Mexico. Only three species are recorded from Canada (Howden, 1968). Previously, only a few species were known to be common to the United States and Mexico. Examination of several thousand specimens from the southwestern United States and northern Mexico discloses that many species are common to both areas.

The adults are nocturnal. In most areas where *Ochodaecus* have been collected, more than one species usually is taken, and it is not uncommon to take three or four species at the same locality on the same night. Very little is known about their biology or immature stages.

The last revisionary work on the United States species of *Ochodaecus* was by Fall (1909) and the genus is currently in need of revision. The present work is an attempt to discover new taxo-

nomie characters and to evaluate their potential for use in revising the genus.

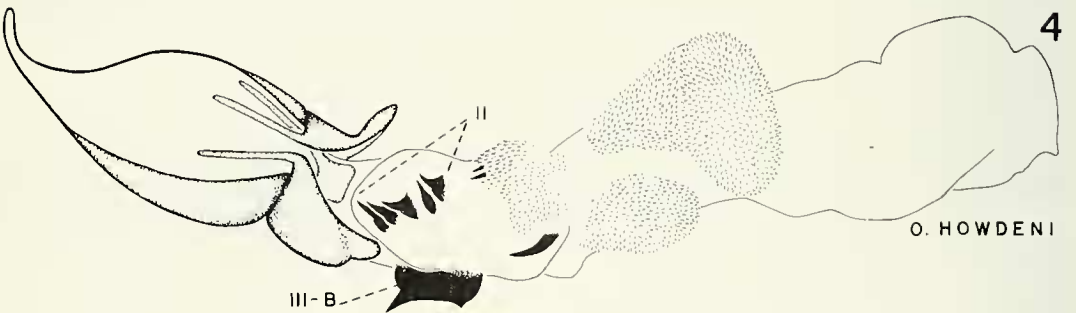
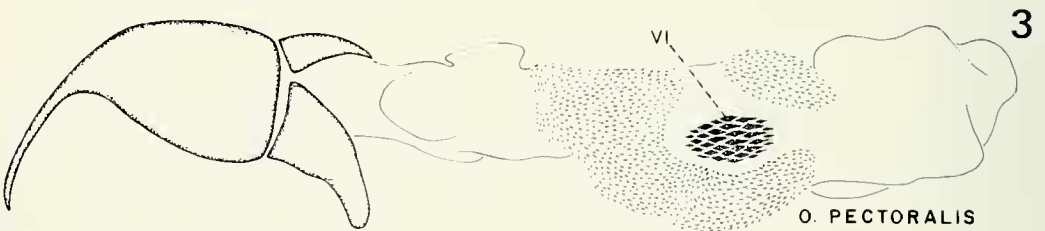
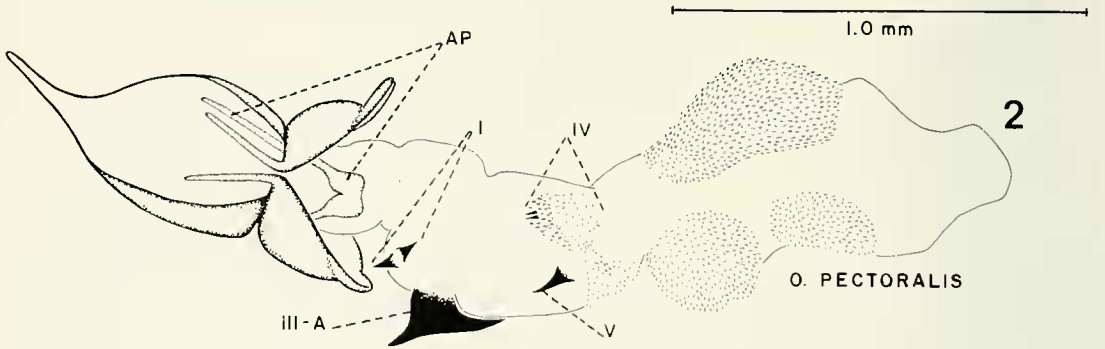
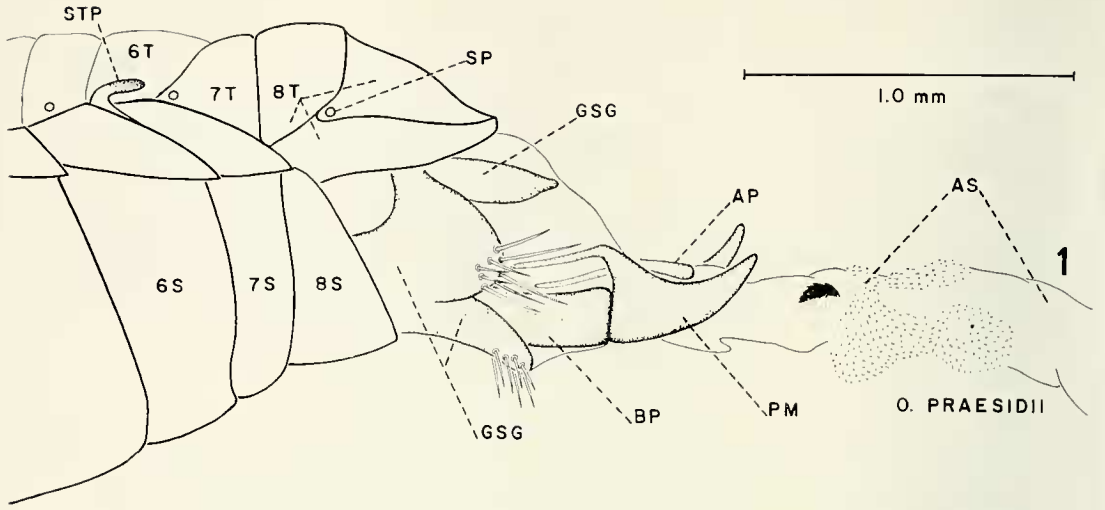
Serville (1828) described *Ochodaecus* and Westwood (1852) published the initial synoptic work. The New World species have been revised by LeConte (1868), Horn (1876), Fall (1909), and Arrow (1911).

Arrow (1904) described the position and morphology of the stridulatory peg and pectinate mesotibial spur (Fig. 15). Using characters associated with these structures he erected the subfamily Ochodaecinae with *Ochodaecus* as its only included genus. Previously, *Ochodaecus* was placed in the Orphniidae. The relationships of *Ochodaecus* to other Scarabaeidae have been considered by Ritcher (1969a, b) and Holloway (1972).

METHODS

Preparation of the male genitalia.—When studying the aedeagal sac, it is best to have the genitalia dissected from the specimen, with the aedeagal sac completely everted. In this condition, the sclerotized structures on the aedeagal sac are fully exposed.

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Figures 1-4. Male genitalic structures of *Ochodaeus* species: 1, *O. praesidii* Bates, abdomen with aedeagus everted; 2, *O. pectoralis* LeConte, aedeagus, dorsal view; 3, *O. pectoralis* LeConte, aedeagus, ventral view;

The best genitalic preparations were made from live specimens by squeezing the specimen between the thumb and index finger until the aedeagus was extruded and aedeagal sac everted. The specimen was then killed and preserved in 70 percent ETOH. Genitalia prepared by this method usually required no further dissection, were easy to study, and displayed the correct spatial relationships of the sclerotized structures.

Preserved specimens were less satisfactory for genitalic preparations. Dried specimens were relaxed and the genitalia removed from the specimen. All genitalic preparations were placed in 60°C KOH for a few minutes, washed in tap water, and then placed in 10 percent acetic acid for a few seconds to neutralize the KOH.

If the aedeagal sac was not everted at all, the inverted sac was slipped inside out over a minuten pin and cut longitudinally. Once the spatial arrangement of the structures for a particular species had been determined from an inflated sac, this type of preparation was used for studying and tabulating variations in the sclerotized structures.

If the aedeagal sac was partially everted, it was manually turned right-side-out using a hooked minuten pin. A fine glass micropipet was then inserted into the sac through the ostium and the sac fully inflated with glycerine. This technique was initially suggested by R. L. Wenzel (pers. comm., P. O. Ritcher).

The flattened aedeagal sac served well for examination and comparison purposes, but an inflated and completely everted sac was used for illustrations.

Preparation of the mouthparts.—The mouthparts were studied on microscope slides or on intact specimens. When a specimen was relaxed for genitalic dissection the mandibles were spread, exposing all of the medial edges, except the basal regions of the molar surfaces. No further dissection was necessary.

Preparation of the stridulatory peg.—In order to study the stridulatory peg it was necessary to lift an clytron slightly or prepare a microscope slide of one side of the abdomen. Slides were prepared by the same method used by Ritcher (1969a) to study abdominal spiracles.

TAXONOMY OF THE GENUS *OCHODAEUS*

The taxonomy of *Ochodaeus* has been worked out primarily at the species level. Previously, no attempt was made to establish infrageneric groups. The *O. pectoralis* complex is erected to contain the nominate species, *O. pectoralis* LeConte, and the two new species described herein. Although no other complexes are designated at this time, a number of currently recognized species are probably complexes of several closely related species.

Taxonomic Characters

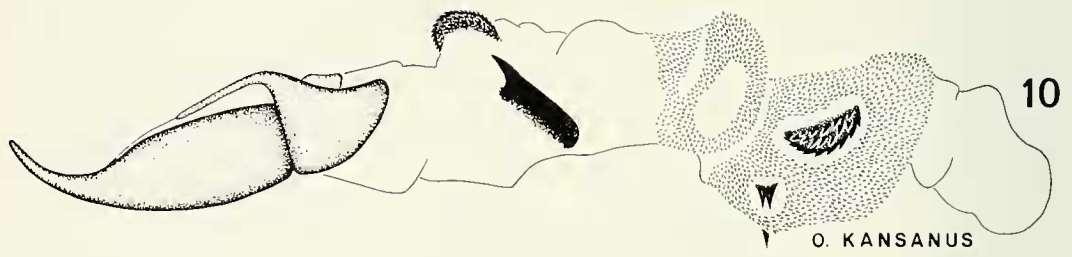
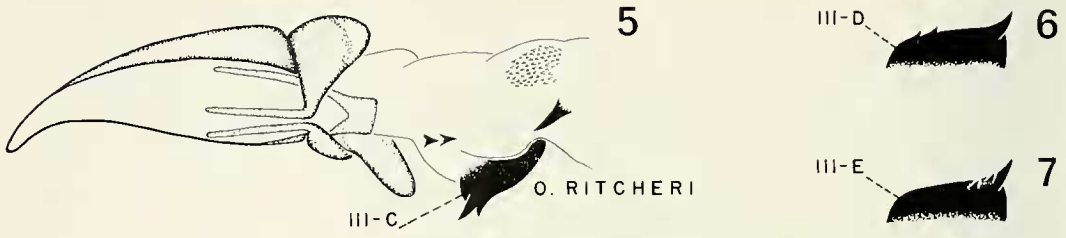
The taxonomic characters previously used included the armature of the legs and head, punctuation of the elytra, sculpturing of the clypeus, shape of the mentum and outer margin of the mandibles, and the nature of the sutural angle of the elytra. The shape of the stridulatory peg and dentition of the mandibles were used in the descriptions of a few Old World species in the early literature, but have not been used for New World species. Genitalic characters have not been used previously in *Ochodaeus*.

Male genitalia.—The terminology used is that of Lindroth and Palmén (1970). The male genitalia in *Ochodaeus* consists of a sclerotized genital segment (gsg) and a group of sclerites and membranous parts which form the aedeagus. The aedeagus consists of the tegmen, formed by the basal piece (bp) and paired parameres (pm), and the penis which is formed by the V-shaped apophysis (ap) and internal sac (as).

The genital segment is presumably derived from the ninth abdominal segment and surrounds and supports the aedeagus (Fig. 1). The aedeagus is attached to the genital segment by membranes at the point of articulation of the basal piece and parameres. When the aedeagus is extended and the internal sac everted, the parameres and internal sac project distad of the genital segment; the basal piece remains enclosed and supported by the genital segment. The shape of the genital segment was similar in all *Ochodaeus* species examined and is of no taxonomic value at the species level.

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4. *O. howdeni*, n. sp. aedeagus, dorsal view. Abbreviations: AP, V-shaped apophysis; AS, aedeagal sac; BP, basal piece; GSG, genital segment; PM, paramere; SP, spiracle; STP, stridulatory peg; 6S, sixth sternite; 6T, sixth tergite.



The basal piece in *Ochodaeus* is an elongate sclerotized process, tapering to a point at the proximal extremity, and enlarged into a semi-circular channel at its distal end where it articulates with the parameres (Figs. 2-4). This structure is the same shape in *Chaetocanthus* Péringuey, *Codocera* Eschscholtz, and *Pseudochodaeus* Carlson and Ritcher (Carlson and Ritcher, 1974). It does not form a continuous tubular structure as in the vaginate type of aedeagus (Lindroth and Palmén, 1970). There is little structural diversification of the basal piece in *Ochodaeus* and consequently it does not provide useful taxonomic characters for distinguishing species. It does, however, provide characters which are useful for assessing generic relationships in the Ochodaeinae.

The parameres articulate with the distal end of the basal piece and form a complete tubular structure through which the aedeagal sac is everted. They are sclerotized, symmetrical, evenly pigmented, and are capable of opening and closing. The points of articulation are in the median plane at the dorsal and ventral surfaces of the aedeagus. The parameres are simple in shape, show little structural diversity, and do not provide useful characters for distinguishing species.

A V-shaped apophysis is attached to the dorsal surface of the aedeagal sac and has a distal margin which is either truncate (Fig. 2) or pointed (Fig. 12). The arms of the apophysis extend cephalad, back through the ostium to about the midpoint of the basal piece. The arms are free of specific articulation with the tegmen, but are attached to a membrane which covers the dorsal surface of the basal piece. The apophysis is sclerotized, evenly pigmented, and gives support to the basal portion of the aedeagal sac when it is everted. The shape of this apophysis is similar in all species considered except *O. biarmatus* LeConte in which its distal margin is pointed (Fig. 12). It does not provide characters for distinguishing other species.

The aedeagal sac is an elongate, membranous structure often bearing numerous sclerotized areas or processes. These processes vary in number, size, and position in each species and may

be hooks, barbs, spines, serrate plates, stellate structures, or groups of spinules. No attempt was made to adopt a terminology or means of coding the various structures and their positions at the generic level. However, a coding system was adopted for the *O. pectoralis* species complex which was useful in determining variation in these structures. Each position on the sac bearing sclerotized structures was given a roman numeral beginning at the basal (proximal) end of the sac. For each position, the number of structures was recorded after the roman numeral. Each shape of a particular process at each position was given a letter, and this was listed, if applicable, after the number of processes present. Thus, the aedeagal sac formula for a species might appear as: I-0, II-1-A, III-3 to 5, IV-1 to 4, V-present, etc.

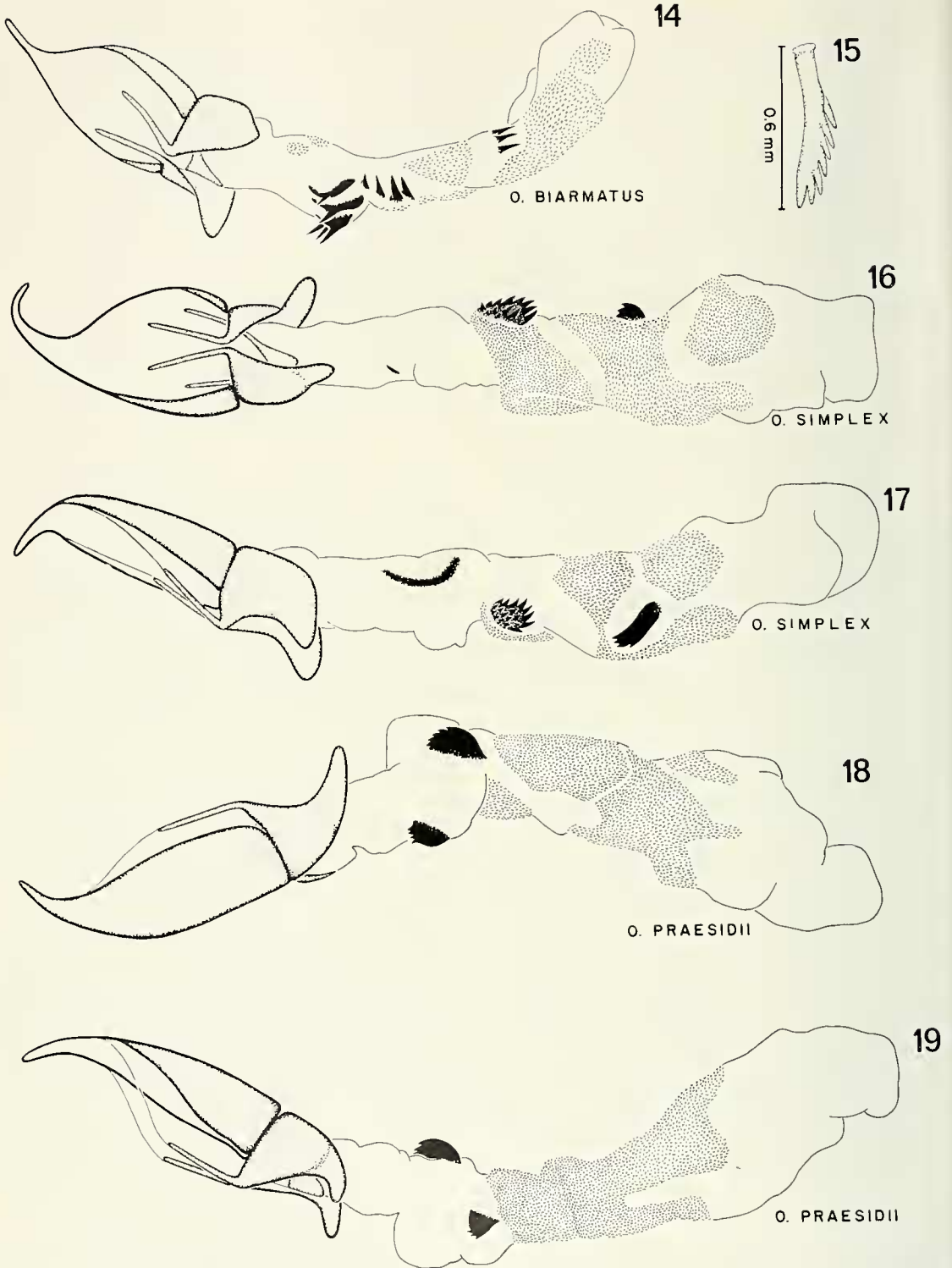
The structures on the aedeagal sac exhibited characters which were useful for distinguishing species. These characters were less variable than many of the external morphological characters and were consequently more reliable for distinguishing species. In most cases other non-genitalic characters supported the differences found in genitalic structures, but these were less apparent. It appears that characters associated with the aedeagal sac will be useful for distinguishing species and indicating relationships between species.

Mouthparts.—Taxonomic characters associated with the mouthparts have been used extensively in *Ochodaeus*. The shape of the mentum is most often used (Horn, 1876; Fall, 1909), and provides characters which are useful for distinguishing the species of the *O. pectoralis* complex.

Although the shape of the labrum was mentioned in the early literature (Westwood, 1852; Horn, 1876), it has not been used in subsequent works. It is used here as a means of distinguishing species in the *O. pectoralis* complex, in which the sculpturing of the dorsal surface is unique (Figs. 28-30).

Westwood (1852) was the only author to figure and use characters associated with the maxillae in

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 Figures 5-13. Aedeagi and associated structures of *Ochodaeus* species: 5, *O. ritchei*, n. sp., aedeagus, dorsal view; 6, *O. howdeni*, n. sp., type-D structure from position III; 7, *O. howdeni*, n. sp., type-F structure from position III; 8, *O. inarmatus* Schaeffer, aedeagus, dorsal view; 9, *O. inarmatus* Schaeffer, aedeagus, ventral view; 10, *O. kansanus* Fall, aedeagus, left lateral view; 11, *O. kansanus* Fall, aedeagus, dorsal view; 12, *O. biarmatus* LeConte, aedeagus, dorsal view; 13, *O. inarmatus* Schaeffer, bifurcate basal structure.



Figures 14-19. 14, *O. biarmatus* LeConte, aedeagus, dorsal view; 15, *O. repandus* Fall, mesotibial spur; 16, *O. simplex* LeConte, aedeagus, dorsal view; 17, *O. simplex* LeConte, aedeagus, right lateral view; 18, *O. praesidii* Bates, aedeagus, left lateral view; 19, *O. praesidii* Bates, aedeagus, right lateral view.

species descriptions. The maxillae were considered in this study, but no useful characters were found.

Horn (1876) and Fall (1909) considered the shape of the outer margin of the mandibles and Westwood (1852) figured and described the medial edges and dentition of the mandibles of several Old World species. The dentition and sculpturing of the inner margin of the mandibles provide excellent taxonomic characters in *Ochodaeus*. This portion of the mandible is subject to wear, but none of the specimens examined had mandibles which were worn to the extent that the dentition was obscured.

The mandibles are asymmetrical and the shape of the left mandible may be used in conjunction with other characters to divide the genus into species complexes. The mandibular dentition of the *O. pectoralis* complex is unique for each species and remains constant despite wear, with the right mandible offering the best characters. Overall size of the mandibles varies with the size of the adult and is not a reliable character.

A system of categorizing the shape of the left mandible was adopted and has been used in the species descriptions. Three types of left mandibles are apparent: type I, unidentate, with apical tooth only, lacking any secondary subapical teeth (Fig. 26); type II, bidentate, with apical portion broad and bladelike, the secondary subapical tooth small, just distad of the membranous prostheca (Figs. 20–21, 24–25, 27); type III, tridentate, apical portion produced into a sharp tooth, secondary and tertiary teeth distad of the prostheca (Fig. 23).

The third tooth of the type III mandible apparently arises from the emarginate apical portion of the type II mandible. The left mandible of *O. kansanus* Fall (Fig. 22) appears to be intermediate between the typical type II mandible (Fig. 20) and the type III mandible (Fig. 23). The left mandible of this species seems to indicate the development of the secondary tooth from the apical portions of the mandible. In the type II mandible, the apical scissorial portion varies from being quite flat to distinctly emarginate.

Stridulatory peg.—Horn (1876) was the first to mention stridulation in *Ochodaeus*, but Arrow (1904) first identified the stridulatory peg, which is located on the sixth sternite (Fig. 1). This peg projects posteriorly and is covered with small tubercles. The area of the elytron adjacent to the peg is thicker than the rest of the elytron and is covered with fine teeth. This appears to be the

area which works against the peg to produce sound.

Chaethocanthus Péringuey and *Pseudochodaeus* Carlson and Ritcher lack stridulatory pegs, but do possess the pectinate mesotibial spur (Carlson and Ritcher, 1974). Examination of a number of *Ochodaeus* in the present study revealed at least one species (*O. mandibularis* Linell) which lacks the stridulatory peg.

Arrow (1904) used the shape of the peg as a character in his description of *O. maculipennis* Arrow and figured the pegs of two European species. *Ochodaeus maculipennis* was found to have a straight projection terminated by numerous sharp teeth while the European species has a bent, rounded club with the apex slightly bulbous. This is the same basic type found in the New World species I examined.

The shape of the stridulatory peg is distinct for each of the species considered (Figs. 40–47) and is the same in both sexes of each species. The magnitude of differences between species in the *O. pectoralis* complex was less apparent than that observed between this complex and the other species considered.

Descriptions of Species

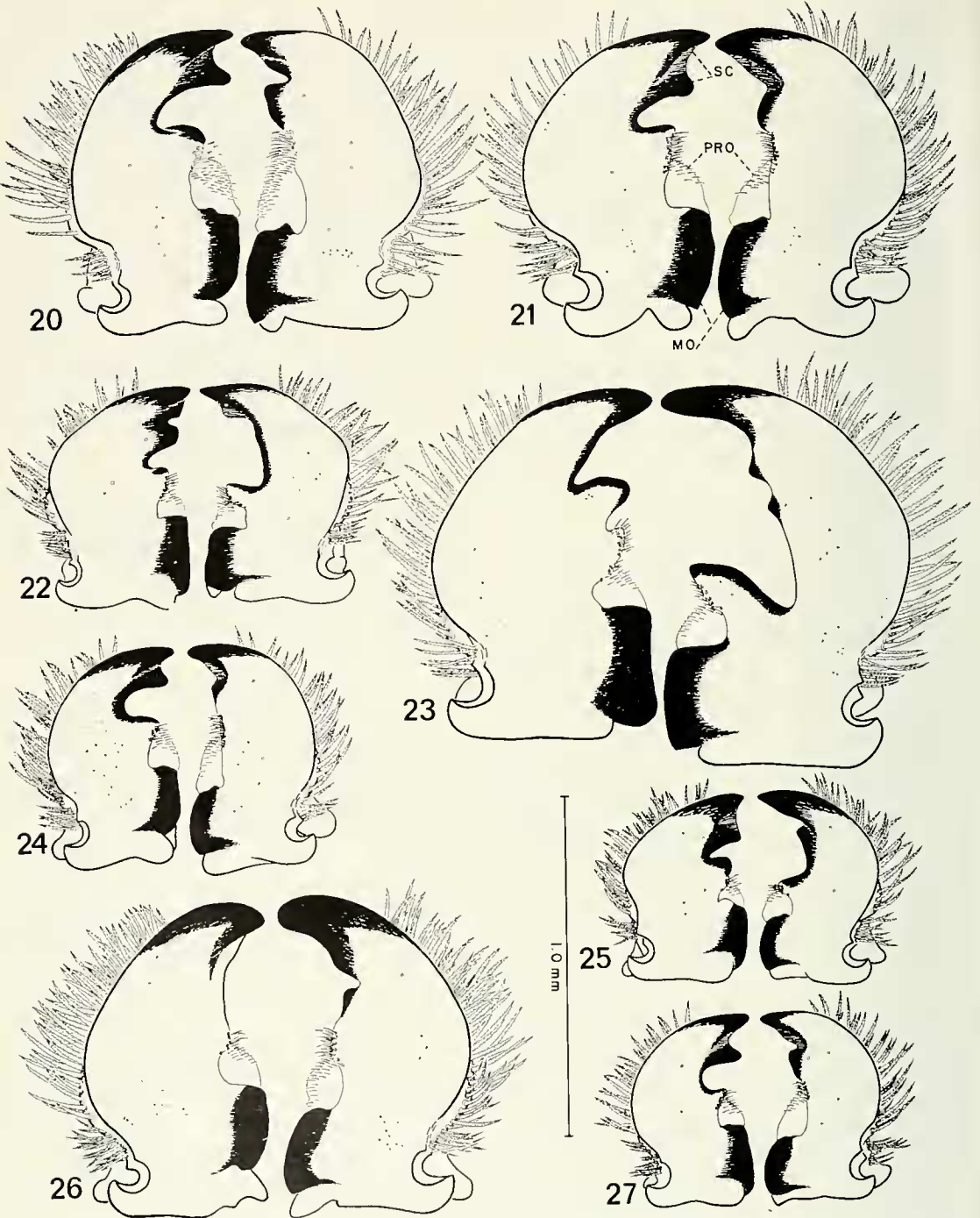
The *O. pectoralis* species complex is considered first as an assemblage and then the three species of the complex are described. The salient characters of five other species are included for comparison and illustrate the variability of these characters within *Ochodaeus*. The holotypes of all the species discussed, except *O. praesidii* Bates, were examined. In the case of *O. praesidii*, a specimen compared with the type at the British Museum (Natural History) by H. F. Howden was examined.

Ochodaeus pectoralis complex

Ochodaeus pectoralis LeConte and the two new species described below are included in the *O. pectoralis* complex. A coding system has been adopted for this complex to facilitate discussion and comparison of the characters of the aedeagal sac (Figs. 2–7).

Description: Male genitalia. V-shaped apophysis truncate. Aedeagal sac with six sclerotic positions I through VI as follows:

- I. Basal series of singular, unipointed spines varying in number from zero to three (Fig. 2).
- II. Secondary basal series of singular, uni-



Figures 20-27. Right and left mandibles of *Ochodaenus* species, dorsal view: 20, *O. howdeni*, n. sp.; 21, *O. inarmatus* Schaeffer; 22, *O. kansanus* Fall; 23, *O. praesidii* Bates; 24, *O. pectoralis* LeConte; 25, *O. biarmatus* LeConte; 26, *O. simplex* LeConte; 27, *O. ritchei*, n. sp. Abbreviations: MO, molar area; PRO, prostheca; SC, scissor area.

pointed spines varying in number from zero to six (Fig. 4).

- III. Large, singular, basal sclerotized structure always present, but varying in shape. Five shapes recognized:
 - A. Simple (Fig. 2).
 - B. One small basal tooth (Fig. 4).
 - C. Two small basal teeth (Fig. 6).
 - D. Two small distal teeth (Fig. 7).
 - E. Apex bidentate (Fig. 5).
- IV. Medially located patch of spiculi; varying in the number of heavily sclerotized and pigmented spiculi from zero to five (Fig. 2).
- V. Solitary, simple spine always present, but varying in size (Fig. 2).
- VI. Ventrally located patch of heavily pigmented and sclerotized spiculi near distal end of sac. Always present in all three species (Fig. 3).

Mouthparts. Mandibles (Figs. 20, 24, 27): Left mandible type II, with apical portion modified into scissorial structure; midpoint of this area evenly indented; secondary tooth set off by large, deep indentation; prosthema located between this tooth and basal molar area. Right mandible bidentate, with apical portion produced into sharp tooth; secondary tooth set off by distinct indentation between it and primary tooth; shape of secondary tooth unique for each species; prosthema anterior to basal molar area, varying in size in each species. Sculpturing and setation of *labrum* (Figs. 28–30) unique for each species. Shape of *mentum* (Figs. 31–34, 36) unique for each species, particularly in degree to which it is produced ventrally. *Stridulatory peg* (Figs. 40–42): Peg similarly shaped in three species, but varies in size, angle of projection, and degree to which apex is enlarged; distal end bluntly rounded.

Remarks: Externally the species of this complex can most easily be distinguished by the sculpturing of the labrum and shape of the mentum. Only one of the series of spines at positions I and II on the aedeagal sac is present in any one species.

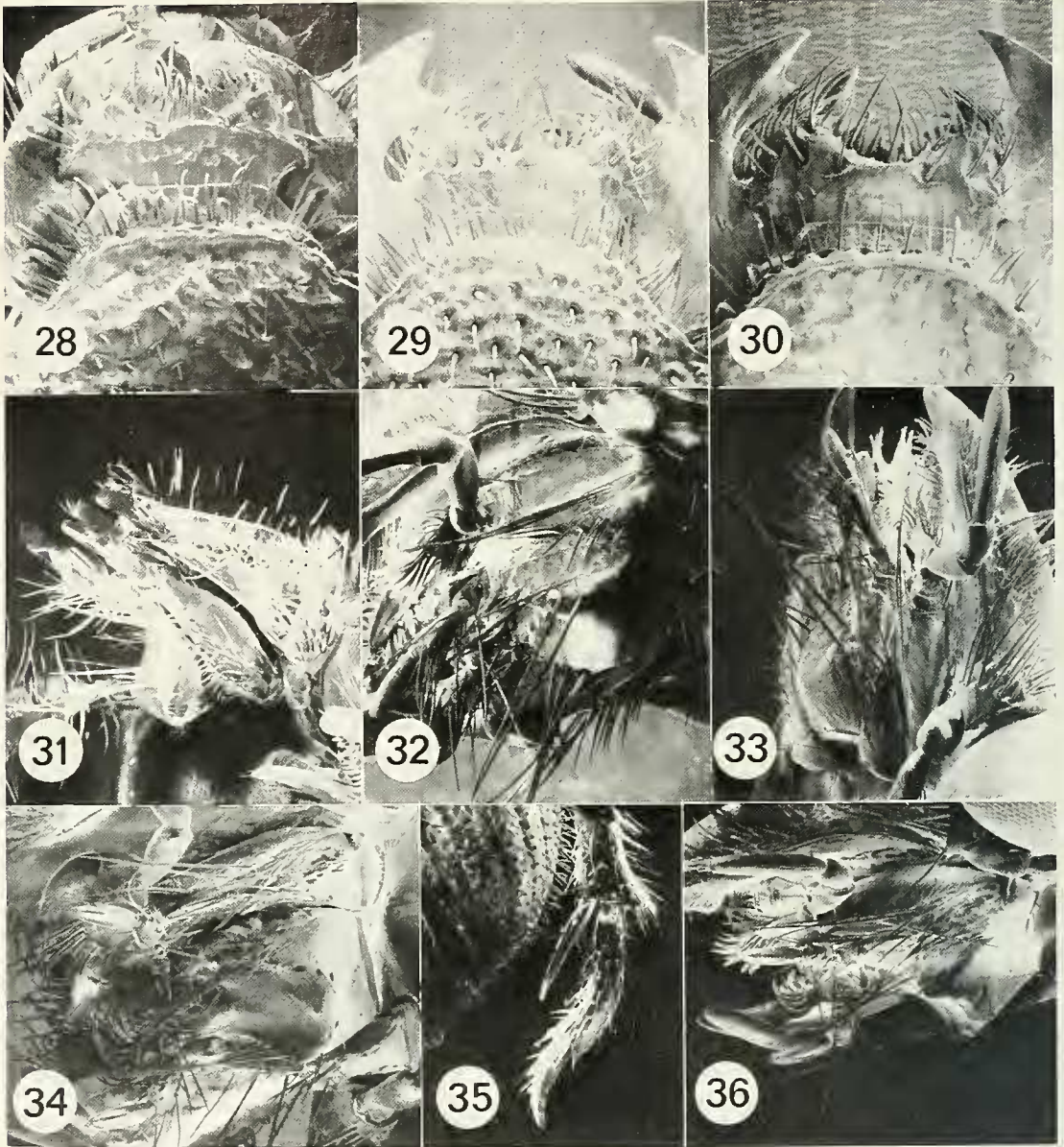
Ochodaecus pectoralis LeConte

Figures 2–3, 24, 28, 31, 35, 37, 40, 48

Ochodaecus pectoralis LeConte, 1868:51; Horn, 1876: 181; Fall, 1909:32; Arrow, 1912:23.

Since two new species closely related to *O. pectoralis* LeConte are being described, it is re-described in detail below.

Description: Male (Holotype). N.M.; Type, M.C.Z., 3335; *O. pectoralis* Lec.; *Ochodaecus pectoralis* Lec. Length 7.5 mm, width through midpoint of elytra 3.9 mm. Mandibles, labrum, clypeus, pronotum, elytra, ventral surfaces, and legs reddish-brown. Frons and vertex mostly reddish-brown, areas adjacent to eyes shading into black. Labrum, clypeus, vertex, pronotum, and elytra covered with yellowish, uniformly short, semi-erect setae. Ventral surfaces, legs, and first antennal segment covered with longer, relatively fine, yellow setae. Mandibles evenly arcuate along outer margin. Labrum (Fig. 28) distinctly emarginate distally, almost bilobed; dorsal surface covered with moderately long setae, each seta set in shallow depression, separated from adjacent setae by raised ridges; proximal half lacks sculpturing, but with transverse row of short, fine setae, anterior to distal margin of preclypeus; postero-lateral margins of labrum concave. Clypeus elevated above labrum, lacking lateral or medial horns; anterior margin slightly reflexed, covered with dense patch of setae. Surface of clypeus and vertex evenly setose, each seta arising just posterior to small tubercle. Posterior margin of head behind eyes lacking setae, closely punctate. Pronotum with marginal bead entire; surface strongly convex, irregularly punctured, and evenly setose, each seta arising from base of small tubercle. Scutellum flat, surface closely punctate, sparsely setose. Each elytron with five punctate striae between median suture and humeral umbone, areas between striae covered with three irregular rows of setae, each seta with basal puncture and tubercle, distance between punctures less than or equal to diameter of individual punctures (Fig. 37). Sutural apex of each elytron dentiform. Propygidium with two tubercles, one on each side of midline. Menthum (Fig. 31) produced ventrally to form transverse wedge, projecting well below ventral edge of maxillae, emarginate anteriorly; anterior surface nearly flat, lacking median ridge; posterior surface of wedge nearly vertical; anterior surface sloping at about 45-degree angle. Prosternum produced anteriorly to form blunt point. Fore tibia tridentate, with proximal tooth median in position; hind femur and tibia lacking dentition, tibia only slightly dilated distally; hind tarsi with first segment arcuate, longer than remaining four segments together; angulation of first metatarsal segment occurring at about apical third. The holotype was not dissected. The descriptions of the genitalia, mandibles, and stridulatory peg which follow are composite descriptions of all of the specimens examined. *Male genitalia* (Figs. 2–3): Basal piece and parameres not distinctive, distal end of V-shaped apophysis truncate. Aedeagal sac formula: I-0 to 3, II-0, III-A, IV-0 to 2, V-present, VI-present. *Mandibles* (Fig. 24): Left mandible type II, apical scissorial portion with shallow, median indentation partially dividing this area into two small teeth; large deep indentation posterior to apical

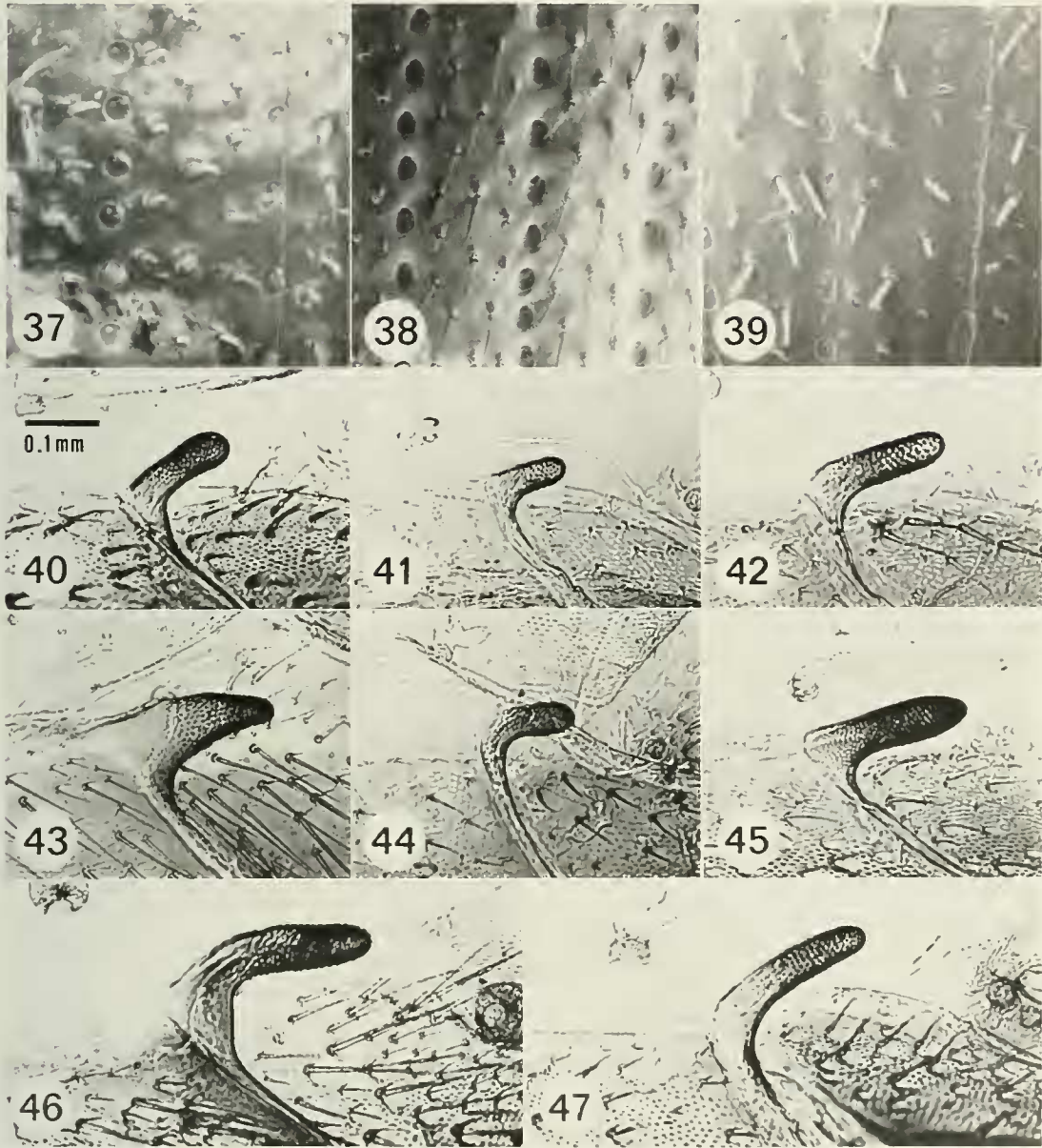


Figures 28–36. 28, *O. pectoralis* LeConte, labrum, dorsal view; 29, *O. ritcheri*, n. sp., labrum, dorsal view; 30, *O. howdeni*, n. sp., labrum, dorsal view; 31, *O. pectoralis* LeConte, mentum, ventro-lateral view; 32, *O. howdeni*, n. sp., mentum, ventro-lateral view; 33, *O. howdeni*, n. sp., mentum, ventro-lateral view; 34, *O. ritcheri*, n. sp., mentum ventro-lateral view; 35, *O. pectoralis* LeConte, metatarsal segments, dorsal view; 36, *O. ritcheri*, n. sp., mentum, ventro-lateral view.

scissorial area separating this area from poorly developed secondary tooth; secondary tooth produced into blunt projection; prosthema posterior to secondary tooth and anterior to basal molar area. Right mandible unidentate, with pointed apical tooth; shallow indentation at base of apical tooth delimiting poorly developed secondary projection; large prosthema adjacent to large basal molar area. Molar area of each

mandible evenly convex. *Stridulatory peg* (Fig. 40): Peg of medium length, projecting dorso-caudad with neck not parallel to longitudinal body axis, distal end bluntly rounded and slightly bulbous.

Female. Females are similar to males in all respects except that the venter of the abdomen is distinctly convex when viewed laterally as compared to the concave venter of males. The first metatarsal



Figures 37-47. 37-39, Dorsal surface of elytra of species in the *O. pectoralis* species complex (200 \times): 37, *O. pectoralis* LeConte; 38, *O. ritcheri*, n. sp.; 39, *O. howdeni*, n. sp.; 40-47, Stridulatory pegs of *Ochodacus* species (all same scale as Fig. 40): 40, *O. pectoralis* LeConte; 41, *O. ritcheri*, n. sp.; 42, *O. howdeni*, n. sp.; 43, *O. simplex* LeConte; 44, *O. biarmatus* LeConte; 45, *O. kansanus* Fall; 46, *O. praesidii* Bates; 47, *O. inarmatus* Schaeffer.

segment in some females appears to be slightly less arcuate than in males.

Variation. In males, length ranges from 4.0 mm to 9.4 mm and width from 2.2 mm to 4.2 mm. In females, length ranges from 4.2 mm to 8.2 mm and width from 2.2 mm to 3.6 mm. Color varies from light brown to dark reddish-brown. The majority of the specimens are dark reddish-brown. Variations in

the sclerotized structures on the aedeagal sac are as indicated in the sac formula above. Of the sixty-two males dissected, the structures at positions I and IV vary most. The most common condition is I-2 and IV-2. The proportions of the structure at position III vary, but retain a basic shape and show no addition of extra teeth. The size of all sclerotized structures vary to a limited extent, but does not affect their

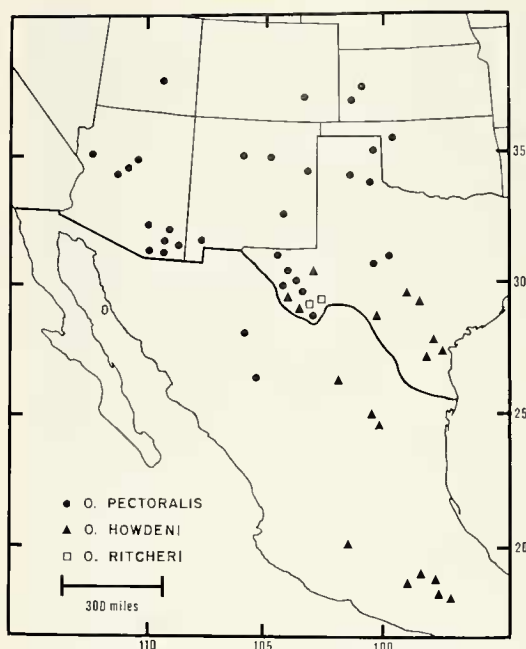


Figure 48. Distribution of species of the *O. pectoralis* species complex in North America and Mexico.

basic shape. The mandibles were quite constant in shape, with only slight variation due to abrasion. The shape of the mentum and stridulatory peg are constant.

Other specimens examined (112 ♂, 159 ♀): UNITED STATES ARIZONA: *Cochise Co* Chiricahua Mts: Cave Creek Ranch, Pinery Cyn. Portal, Southwestern Research Station, Turkey Creek; Dragoon Mts; Cochise Stronghold; Huachuca Mts: Garden Cyn, Flying H Ranch; Sierra Vista; Tombstone; 8 mi E Wilcox. *Coconino Co* Midgley Bridge, Oak Creek Cyn; Sedona. *Mohave Co* 6 mi SE Kingman. *Navajo Co*. *Pima Co* Stratton, S Catalina Mts, 6700 ft. *Pinal Co* near Oracle. *Santa Cruz Co* Canelo. *Yavapai Co* Jerome, Red Rock Camp, Prescott, 4 mi W Prescott. COLORADO: *Otero Co* Rocky Ford. KANSAS: *Kearny Co* Kendal. *Scott Co*. NEW MEXICO: *Chaves Co* Roswell. *Eddy Co* Guadalupe Mts: Sitting Bull Falls. *Luna Co* 26 mi W Deming. *Quay Co* San Jon. *Sandoval Co* Jemez Spgs: Sulphur Dam, 5 mi N Jemez Spgs. *San Miguel Co* Las Vegas. OKLAHOMA: *Woodard Co* Woodard. TEXAS: Hot Spgs. *Brewster Co* Alpine: Big Bend National Park; Tornillo Flat: S. G. Ranch. *Coleman Co* Hords Creek Res. *Culberson Co* Kent. *Hall Co* 5 mi W Memphis. *Hemphill Co* Canadian. *Hudspeth Co* Guadalupe Pass. *Jeff Davis Co* Davis Mts: Limpia Cyn, Madera Cyn Park; Ft. Davis; 1 mi W Ft. Davis; Valentine. *Randall Co* Palo Duro Cyn State Park. *Reeves Co* 40 mi W Ft. Stockton. *Tom Green Co* Highland Park Cmpgnd near San Angelo. *Val Verde Co*. UTAH: *Wayne Co* Bull

Creek, 5000 ft, 15 mi S Hanksville; Fairview Ranch, 5000 ft, 13 mi S Hanksville. MEXICO CHIHUAHUA: Arroyo Catarinas, 15 mi S Matamoras; Catarinas; 12 mi N Chihuahua; Valle de Olivos, 5500 ft. COAHUILA: Rancho la Encontada, 5200 ft, Sierra del Carmen. DURANGO: Nombre de Dios, 5900 ft; Pedricena, 4500 ft. Collection dates range from April 15 through October 30, with the largest numbers in July and August.

Remarks: This species, as well as the two new species, will key to *O. pectoralis* LeConte in Fall's (1909) key. *Ochodaes pectoralis* LeConte can be distinguished from them by the greatly reduced mentum, by the large size of elytral punctures relative to the distance between punctures, by the first metatarsal segment which is angulate at the apical third, and by its labrum which lacks a median projection. These species can also be distinguished from each other by differences in the sclerotized structures on the aedeagal sac (Figs. 2-5).

Ochodaes howdeni, new species
Figures 4, 6-7, 20, 30, 32-33, 42, 48

Description: Male (Holotype). Mexico, near Jame, Coahuila, 33 mi SE Saltillo, 7500 ft, 25 July 1963, H. F. Howden (CNC #13,467). Length 8.9 mm, width through midpoint of elytra 4.3 mm. Mandibles, labrum, clypeus, pronotum, elytra, ventral surfaces, and legs largely dark reddish-brown. Frons and vertex mostly brown, areas adjacent to eyes shading into black. Labrum, clypeus, vertex, pronotum, and elytra covered with yellowish, uniformly short, semi-erect setae. Ventral surfaces and legs covered with longer, relatively fine, yellow setae. Mandibles (Fig. 20) evenly arcuate along outer margin. Left mandible type II, apical scissorial portion with median indentation partially dividing this area into two small teeth; large, deep indentation posterior to apical scissorial area delimiting secondary tooth, this tooth only slightly developed; relatively large prostheca just anterior to large molar area. Right mandible bidentate, apical piercing tooth with shallow basal indentation separating it from bilobed secondary tooth just anterior to large prostheca, molar area smaller than left mandible. Molar areas of each mandible evenly convex. Labrum (Fig. 30) distinctly emarginate distally, almost bilobed; dorsal surface covered with sparse, moderately long setae, each seta set in shallow depression, separated from adjacent setae by raised ridges; proximal half lacks sculpturing, but has transverse row of short, fine setae, anterior to distal margin of preclypeus; postero-lateral margins of labrum concave. Clypeus elevated above labrum, lacking lateral or medial horns; anterior margin slightly reflexed, covered with dense patch of setae. Surface of clypeus and vertex evenly setose, each seta

arising just posterior to small tubercle. Posterior margin of head behind eyes lacking setae, closely punctate. Pronotum with marginal bead entire: surface strongly convex, irregularly punctured, and evenly setose, each seta arising from base of small tubercle. Scutellum flat, surface closely punctate, sparsely setose. Each elytron with five punctate striae between median suture and humeral umbone, areas between striae covered with three irregular rows of setae, each seta with basal puncture and tubercle, distance between punctures greater than diameter of individual punctures (Fig. 39), sutural apex of each elytron dentiform. Propygidium with two tubercles, one on each side of midline. Mentum (Figs. 32-33) produced ventrally to form shallow transverse wedge, projecting only slightly below ventral edge of maxillae, emarginate anteriorly, and longitudinally impressed. Prosternum produced anteriorly to form blunt point, posterior margin with projection at midline. Fore tibia tridentate, with proximal tooth median in position; hind femur and tibia lacking dentition, tibia only slightly dilated distally; hind tarsi with first segment arcuate, longer than remaining four segments together; angulation of first metatarsal segment even, bend occurring near middle. *Genitalia* (Figs. 4, 6-7): Basal piece and parameres not distinctive, distal end of V-shaped apophysis truncate. Aedeagal sac formula: I-0, II-5, III-B, IV-4, V-present, VI-present. *Stridulatory peg* (Fig. 42): Peg long, projecting dorso-caudad with neck not parallel to longitudinal body axis, distal end bluntly rounded, not bulbous. Edges of peg parallel, not tapering distally.

Female (*Allotype*). Mexico, Coahuila, near Jame, 33 mi SE Saltillo, 7500 ft, 25 July 1963, A. T. Howden (HFH). Length 7.6 mm, width through midpoint of elytra 3.6 mm. Color uniformly reddish-brown except for darkening around eyes. First metatarsal segment less stout and arcuate than male, venter of abdomen evenly convex when viewed laterally; similar to male in other respects.

Paratypes (52 ♂ 33 ♀): UNITED STATES TEXAS: 1 ♂ (AMNH); 1 ♂, Horn collection H5577 (ANSP). *Brewster Co* Big Bend National Park: 1 ♂ 1 ♀, 10 June 1948, L. J. Bottimer (CNC); 4 ♂ 2 ♀, Basin, 13 August 1950, R. F. Smith (AMNH); 1 ♂, Chisos Basin, 16-17 July 1973, F. T. Hovore (DCC); 1 ♀, Chisos Mts, 4-6 July 1961, R. L. Westcott (RLW); 1 ♂ 3 ♀, Dugout Wells, 27 August 1965, A. Blanchard (ARH); 1 ♀, Green Gulch, Chisos Mts, 25-27 August 1965, A. Blanchard (LACM); 2 ♀, Green Gulch, 5700 ft, 3 August 1968, J. E. Hafernik (TAMU); 2 ♂, Juniper Cyn, Chisos Mts, 13-14 July 1928, F. M. Gaige (HFH, UM); Chisos Mts: 1 ♂, 17 July 1946, D. J. and J. N. Knull (OSU); 1 ♀, 28 July 1962, D. J. and J. N. Knull (HFH); 1 ♂ 22 June 1967, D. J. and J. N. Knull (OSU); 1 ♂ 1 ♀, Big Bend, 2-4 July 1946, VanDyke collection (CAS). *Duval Co* 1 ♀, Sepulveda Ranch, 6 June 1970, C. W. Griffin (ORSU).

Jeff Davis Co 1 ♀, Davis Mts St Park, 18-21 July 1973, F. T. Hovore (DCC). *Kendal Co* 1 ♂ 1 ♀, vicinity "Cave without Name" near Boerne, 30 July 1968, G. E. Ball (AMNH). *Kerr Co* 1 ♂, Kerrville, 27 May 1906, J. D. Mitchell (USNM). *Kinney Co* 1 ♂ 1 ♀, 7 mi E Brackettville, 25 September 1971 R. Turnbow (RHT). *Maverick Co* 3 ♂ 2 ♀, 24 May 1940, M. Marquis (CAS). *Nueces Co* 1 ♂, Corpus Christi, 6 October 1951, O. L. Cartwright and A. B. Gurney (USNM). *Presidio Co* 1 ♂ 1 ♀, Shafter, 2 August 1968, M. L. Allender (TAMU). *San Patricio Co* 4 ♀, Mathis, 4 June 1964, H. R. Burke (TAMU). MEXICO COAHUILA: same locality as holotype; 3 ♂, 7500 ft, 18 July 1963, H. and A. Howden (CNC); 3 ♂, 7000 ft, 18 July 1963, A. Howden (HFH); 3 ♂ 1 ♀, 7500 ft, 18 July 1963, A. T. Howden (HFH); 1 ♂ 1 ♀, 7500 ft, 18 July 1963, Arnett and Van Tassell (HFH, CNC); 2 ♂ 2 ♀, 7500 ft, 25 July 1963, H. F. Howden (CNC); 5 ♂, 20 mi SE Saltillo, 6000 ft Rt. 015, 20-21 June 1971, H. F. Howden (HFH); 1 ♀, 9 mi E Quatro Cienegas, 2200 ft, 24 September 1958, T. J. Cohn (UM); 1 ♂, Coahuila, Horn collection, H5577 (ANSP). DURANGO: 1 ♂ 2 mi S Menores de Arriba, 14 September 1950, R. F. Smith (AMNH). GUANAJUATO: 3 ♂ 3 ♀, 22 mi E Penjamo, 5200 ft, 20 September 1968, A. R. Hardy, L. Espinosa, and J. P. Abrayaya (ARH). GUERRERO: 1 ♀, vicinity Acuitlapan, 10 mi NE Taxco, 5000 ft, 4-5 September 1970, E. M. and J. L. Fisher (ARH). MORELOS: 3 ♂ 1 ♀, Cañon del Lobos, 3 mi W Yautepec, 12-13 July 1970, E. Fisher and P. Sullivan (ARH). PUEBLA: 1 ♂, 13 mi SE Acatlan, 25 August 1964 (ARH); 3 ♂, 34 mi S Atlixco, 27 June 1957, J. A. Chemsak and B. J. Rannels (UCB, HFH); 1 ♂, 7 mi N Izucar de Matamoros, 4000 ft, 8-9 June 1971, H. F. Howden (HFH); 1 ♂, 12 mi SE Izucar Matamoros, 5 September 1969, S. and J. Peck (HFH).

Variation: In males length ranges from 5.8 mm to 8.9 mm and width from 2.9 mm to 4.3 mm. In females length ranges from 5.1 mm to 7.8 mm and width from 2.7 mm to 4.3 mm. Color varies from tan to a dark reddish-brown. Variation in the sclerotized structures on the aedeagal sac is: II-3 to 6, III-A or B or C or D, IV-0 to 5. The structures at positions II and IV are constant in shape, but vary in number. In some specimens the two faintly raised tubercles on the vertex are not visible. Variation in the mouthparts and stridulatory peg is slight.

Remarks: This species will key to *O. pectoralis* LeConte in Fall's (1909) key. *Ochodaenus howdeni* can be distinguished from *O. pectoralis* LeConte by the slightly produced mentum, by the small size of elytral punctures relative to the distance between punctures, and by the first metatarsal segment which is angulate at its midpoint. The secondary tooth of the right mandible reaches its greatest development in this species of the

O. pectoralis complex. These species can also be distinguished by differences in the sclerotized structures on the aedeagal sac (Figs. 2-4). The holotype is in the Canadian National Collection (CNC #13,467) and the allotype is in the personal collection of H. F. Howden (HFH). The paratypes are in the collections indicated in parentheses.

I am pleased to name this species after Henry F. Howden who collected a large part of the type material and assisted me with this study.

***Ochodaeus ritcheri*, new species**

Figures 5, 27, 29, 34, 36, 38, 41, 48

Description: Male (Holotype). Texas, Big Bend National Park, Panther Jct. 4000 ft, 12 May 1959, Howden and Becker (CNC #13,468). Length 6.7 mm, width through midpoint of elytra 3.4 mm. Mandibles, labrum, clypeus, head, pronotum, ventral surfaces, and legs dark reddish-brown. Elytra slightly lighter in color. Labrum, clypeus, head, pronotum, and elytra covered with yellowish, uniformly short, semi-erect setae. Ventral surfaces and legs covered with longer, relatively fine setae. Mandibles (Fig. 27) evenly arcuate along outer margin. Left mandible type II, apical scissorial portion with median indentation partially dividing this portion into two small teeth; large, deep indentation posterior to apical scissorial area, delimiting secondary tooth, this tooth developed only slightly, rounded and narrow; relatively small prostheca anterior and adjacent to basal molar area. Right mandible bidentate, apical piercing tooth with shallow, basal indentation separating it from secondary tooth, not bilobed, just anterior to large prostheca. Basal molar area of each mandible evenly convex. Labrum (Fig. 29) distinctly emarginate anteriorly, almost bilobed; small pointed projection arising at midpoint of emargination on dorsal surface; anterior dorsal surface covered with sparse setae, each seta arising from shallow depression, separated from adjacent setae by fine ridges; posterior half of labrum lacking sculpturing, but with transverse row of very small, fine setae, anterior to distal margin of preclypeus; postero-lateral margins of labrum concave. Clypeus elevated above labrum, lacking lateral or medial horns; anterior margin slightly reflexed, covered with dense patch of setae. Surface of clypeus and vertex evenly setose, each seta arising at base of small tubercle. Vertex evenly convex, except for shallow depression at center just anterior to eyes; two slightly elevated areas on head between eyes. Posterior margin of head closely punctured, lacking setae and tubercles. Pronotum with marginal bead entire, surface strongly convex, irregularly punctured, and evenly setose, each seta arising at base of small tubercle. Scutellum flat, closely punctured, and sparsely setose. Each elytron with five punctate

striae between median suture and humeral umbone, areas between striae with three irregular rows of setae, each seta arising from base of small tubercle, distance between punctures in elytral striae equal to or less than diameter of individual punctures (Fig. 38), sutural apex of each elytron dentiform. Propygidium with two tubercles, one on each side of midline. Mentum (Figs. 34, 36) produced ventrally to form transverse wedge extending considerably below ventral edge of maxillae, emarginate anteriorly, longitudinally impressed, with slight ridge at midpoint. Prosternum produced anteriorly to form blunt point, posterior margin with projection at midpoint. Fore tibia tridentate, basal tooth located approximately at midpoint between base of tibia and apical tooth, hind femur lacking apical unciform tooth, posterior apical margin with slightly produced edge, hind tibia lacking dentition and dilated only slightly at apex, hind tarsus with first segment as long as remaining four segments together, triangular in cross section, and arcuate, angulation occurring at approximately one-third distance from apex. *Genitalia* (Fig. 5): Basal piece and parameres not distinctive, distal end of V-shaped apophysis truncate. Aedeagal sac formula: I-2, II-0, III-E, IV-0, V-present, VI-present. *Stridulatory peg* (Fig. 41): Peg short, projecting caudad and slightly dorsal, with neck not quite parallel to longitudinal body axis, distal end bluntly rounded, not bulbous. Edges of peg parallel, not tapering distally.

Female (Allotype). Same data as holotype. Length 7.2 mm, width through midpoint of elytra 3.3 mm. Color uniformly dark reddish-brown with setation similar to male, labral projection same as in male. Similar to holotype in all other respects, except that venter of abdomen is evenly convex when viewed laterally.

Paratypes (2 ♂ 8 ♀): UNITED STATES TEXAS: Brewster Co Big Bend National Park: 1 ♂, Panther Jct, 4000 ft, 12 May 1959, Howden and Becker (CNC); 1 ♀, Tornillo Flat, 3200 ft, 5 May 1959, Howden and Becker (CNC); 1 ♂ Tornillo Flat 3200 ft, 20 May 1959, Howden and Becker (CNC); 4 ♀, Oak Springs, 25 August 1965, A. Blanchard (LACM); 2 ♀, Big Bend Oak Springs, 26 August 1965, A. and M. E. Blanchard (ARH); 1 ♀, Chisos Basin, 16-17 July 1973, F. T. Hovore (DCC).

Variation: A complete indication of the variation is difficult due to the limited amount of type material available. In males, length ranges from 6.1 mm to 6.7 mm and width from 3.1 mm to 3.5 mm. In females, length ranges from 5.1 mm to 6.7 mm and width from 2.7 mm to 3.3 mm. Color varies from light to very dark reddish-brown with some variation resulting from the type of treatment given to relax and remove the genitalia. The only variation in the male genitalia occurs at position III. The sclerotized structure at this position varies in the degree to which the apical teeth are produced. In one specimen the subapical tooth is greatly reduced. The two faintly

raised tubercles on the vertex are visible in some specimens and completely lacking in others. Variation in the mouthparts and stridulatory peg is slight.

Remarks: This species will key to *O. pectoralis* LeConte in Fall's (1909) key. *Ochodaenus ritcheri* can be distinguished from *O. pectoralis* LeConte by the median projection of the labrum occurring in *O. ritcheri*. The secondary tooth on the left mandible in *O. ritcheri* is smaller and more rounded than in the other species of the *O. pectoralis* species complex. The shape of the right mandible in *O. ritcheri* more closely resembles the right mandible of *O. howdeni* than that of *O. pectoralis* LeConte. *Ochodaenus ritcheri* can also be distinguished from *O. howdeni* and *O. pectoralis* LeConte by the sclerotized structures on the aedeagal sac (Figs. 2-5). The holotype (CNC #13,468) and allotype are in the Canadian National Collection. Paratypes are in the collections indicated in parentheses.

I am pleased to name this species after my major professor, Paul O. Ritche, who assisted me a great deal with this study. I am indebted to him for suggesting the topic, making the preliminary investigations into the possibility of using the aedeagal sac, and for accompanying me on collecting trips.

KEY TO THE SPECIES OF THE *OCHODAEUS PECTORALIS* SPECIES COMPLEX (ADULTS)

- 1a. First metatarsal segment arcuate, longer than remaining four segments together; mentum produced ventrally to form transverse wedge; sutural angle of elytra dentiform (*O. pectoralis* complex) 2
- b. First metatarsal segment not arcuate, not longer than remaining four segments together; mentum not produced ventrally to form transverse wedge (if mentum is produced ventrally then sutural angle of elytra not dentiform) ... all other species.
- 2a. Labrum with median projection on dorsal surface *O. ritcheri*, new species.
- b. Labrum without median projection on dorsal surface 3
- 3a. Mentum produced well below ventral surface of maxillae; first metatarsal segment with angulation occurring at apical one-third; distance between elytral punctures approximately equal to diameter of individual punctures
..... *O. pectoralis* LeConte.
- b. Mentum produced only slightly below ventral surface of maxillae; first metatarsal segment with angulation occurring at midpoint; distance between elytral punctures larger than diameter

of individual punctures
..... *O. howdeni*, new species.

Five species other than those of the *O. pectoralis* species complex were examined to determine the array of structural differences found in the aedeagal sac, mandibles, and stridulatory peg. Differences are briefly outlined below. For a key to these species see Fall (1909).

Ochodaenus inarmatus Schaeffer Figures 8-9, 13, 21, 47

Ochodaenus inarmatus Schaeffer, 1906:270; Fall, 1909:34; Arrow, 1912:22.

Type material: Two Cotypes: Males. United States National Museum. Type: Huachuca Mts., Ariz., Brooklyn Museum, Coll., 1929; Catal. No. 924; Cotype, No. 42575, USNM; *Ochodaenus inarmatus* Schaeff., type; *Ochodaenus inarmatus* Schaeff. I designate this specimen as lectotype. The other cotype, which is undissected, has an additional mentum mounted on a point below the specimen and lacks the second determination label.

Description: *Male genitalia* (Figs. 8-9, 13): V-shaped apophysis truncate. Aedeagal sac with four distinct sclerotic regions. *Mandibles* (Fig. 21): Left mandible type II; right mandible bidentate. *Stridulatory peg* (Fig. 47): Peg long, slightly arcuate, projecting dorso-caudad with neck not parallel to longitudinal body axis; distal end bluntly rounded, not bulbous; sides of peg parallel, not tapering distally.

Other specimens examined (76): UNITED STATES ARIZONA. MEXICO DURANGO.

Remarks: The only apparent variation in the sclerotized structures on the aedeagal sac is in the first basal structure. In some specimens the distal end of this structure is bifurcate (Fig. 13). The illustrations are of specimens taken at the Southwestern Research Station, 5 mi W Portal, Arizona.

Ochodaenus kansanus Fall Figures 10-11, 22, 45

Ochodaenus kansanus Fall, 1909:34; Arrow, 1912:23.

Type material: *Holotype:* Male. Museum of Comparative Zoology, Harvard. Hamilton Co., Ks. 3350 ft, F. H. Snow; ♂; Type *kansanus*: M.C.Z. Type 24778.

Description: *Male genitalia* (Figs. 10-11): V-shaped apophysis truncate. Aedeagal sac with three serrate and one stellate, heavily pigmented, sclerotized structures; variable number of simple spines at distal end. *Mandibles* (Fig. 22): Left mandible type II, intermediate in shape between type II and type III mandibles; right mandible bidentate. *Stridulatory peg* (Fig. 45): Peg long, projecting caudad with neck parallel to longitudinal body axis; sides not parallel.

but narrow at base, bulbous at midpoint, and tapering to blunt point at apex.

Other specimens examined (200): UNITED STATES ARIZONA, COLORADO, KANSAS, NEBRASKA, NEW MEXICO, TEXAS. MEXICO CHIHUAHUA, DURANGO.

Remarks: There is little variation in the sclerotized structures on the aedeagal sac except in the simple structures at the distal end and the stellate structure. The simple teeth vary in number and shape and the stellate structure is lacking in some specimens bearing the same label as the type. Other specimens identical in all other respects possess this stellate structure. More than one distinct form keys out to this species in Fall's (1909) key. The illustrations are of specimens taken 26 mi W Deming, New Mexico.

Ochodaeus biarmatus LeConte

Figures 12, 14, 25, 44

Ochodaeus biarmatus LeConte, 1868:51; Horn, 1876: 182; Fall, 1909:35; Arrow, 1912:21.

Type material: Holotype: Male. Museum of Comparative Zoology, Harvard. N.M.; *O. biarmatus* Lec.; Type, M.C.Z., 3338.

Description: Male genitalia (Figs. 12, 14): V-shaped apophysis pointed. Aedeagal sac with two stellate patches, basally; series of nine or ten spines medially; series of three spines distally. *Mandibles* (Fig. 25): Left mandible type II; right mandible tridentate. *Stridulatory peg* (Fig. 44): Peg small, projecting caudad with neck parallel to longitudinal body axis; apex bluntly rounded, not bulbous; sides of peg parallel, not tapering distally.

Other specimens examined (740): UNITED STATES ARIZONA, COLORADO, NEW MEXICO, TEXAS. MEXICO CHIHUAHUA, COAHUILA, DURANGO, SONORA.

Remarks: Several distinct forms key to this species in Fall's (1909) key. Some of the specimens which key to this species lack acute dentition on the hind femur and some lack tubercles on the anterior clypeal margin. The illustrations are of specimens taken at the Southwestern Research Station, 5 mi W Portal, Arizona.

Ochodaeus simplex LeConte

Figures 16-17, 26, 43

Ochodaeus simplex LeConte, 1854:222; Horn, 1876: 182; Fall, 1909:32; Arrow, 1912:24.

Type material: Holotype: Female. Museum of Comparative Zoology, Harvard. C; *O. simplex* Lec., Webb, Copper Mines; Type 3340.

Description: Male genitalia (Figs. 16-17): V-shaped apophysis truncate. Aedeagal sac with two simple structures basally; spinous plate medially; elongate serrate structure distally. *Mandibles* (Fig.

26): Left mandible type I; right mandible bidentate. *Stridulatory peg* (Fig. 43): Peg medium in length, projecting caudad with neck parallel to longitudinal body axis; apex bluntly pointed; sides of peg not parallel, but tapering from broad base to bluntly pointed apex.

Other specimens examined (56): UNITED STATES ARIZONA, COLORADO, MONTANA, NEW MEXICO, OREGON, TEXAS, UTAH. MEXICO CHIHUAHUA.

Remarks: The only apparent variation in the structures on the aedeagal sac is in the pigmentation and development of the teeth of the spinous plate. The illustrations are of specimens taken 13 mi SE Sisters, Oregon.

Ochodaeus praesidii Bates

Figures 1, 18-19, 23, 46

Ochodaeus praesidii Bates, 1887:106; Fall, 1909:36; Arrow, 1912:23.

Type material: The holotype is in the British Museum of Natural History, London, and was not examined. A specimen compared with the holotype at the British Museum by Henry F. Howden was examined and dissected. This specimen was taken at Tuxpan, Nayarit, Mexico. According to H. F. Howden (pers. comm.) the holotype is a male. The type locality is Praesidio, Mexico.

Description: Male genitalia (Figs. 1, 18-19): V-shaped apophysis truncate. Aedeagal sac with three serrate plates occurring basally. *Mandibles* (Fig. 23): Left mandible type III; right mandible with two large and two small teeth. *Stridulatory peg* (Fig. 46): Peg long, acutely arcuate with distal two-thirds projecting caudad, parallel to longitudinal body axis; apex bluntly rounded, not bulbous; sides of peg divergent at base, becoming parallel along apical two-thirds.

Other specimens examined (820): UNITED STATES ARIZONA, TEXAS. MEXICO CHIHUAHUA, DURANGO, NAYARIT, SINALOA, SONORA.

Remarks: The sclerotized structures on the aedeagal sac of the specimen compared with the holotype are identical to those figured. The illustrations are of specimens taken at the Southwestern Research Station, 5 mi W Portal, Arizona.

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